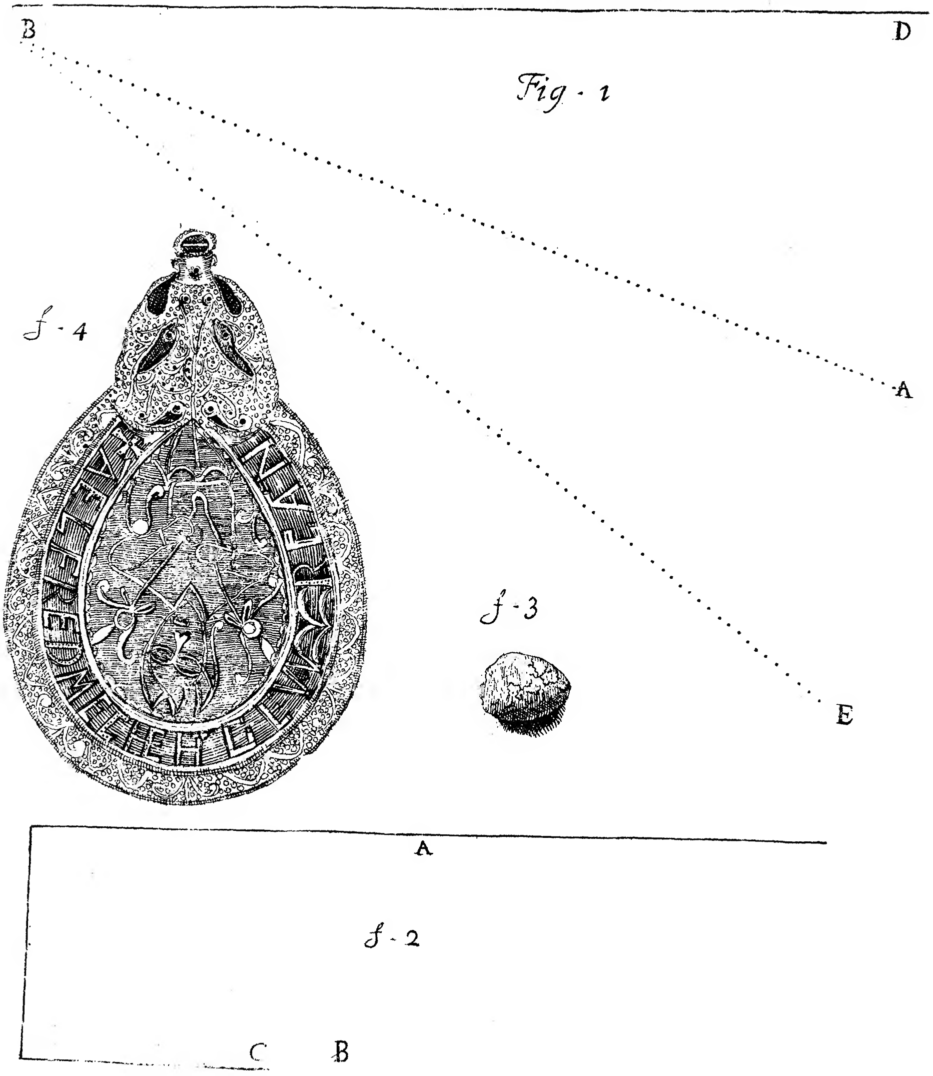
Philos. Transact. No. 247



II. *Some Experiments and Obſervations concerning* Sounds. *By Mr.* Walker, *late of* Brazen-Noſe-College, Oxon. *Communicated by Dr.* W. Muſgrave, *Fell. Coll. Phyſ. and R. S.*

INtending to try the Swiftneſs of Sounds, I provided a Pendulum which had Two Vibrations in 1″ of Time; this I carefully adjuſted at a Watch-maker's; it was a Piece of ſmall Virginal Wire with a Piſtol Bullet at the end of it, the Length of it was 9 $\frac{8}{10}$ Inches to the middle of the Bullet: I firſt made it about $\frac{2}{10}$ of an Inch longer, *viz.* $\frac{1}{4}$ of the length of a Pendulum that vibrates 2*ds*, but found it too ſlow, which I expected, becauſe *Merſennus* tells us, [*Harm. Univ. l.* 2. *pro.* 26.] that Two Pendulums had their Vibrations one twice as quick as the other, whereas one was 2 Foot, the other 8 $\frac{1}{2}$ Foot contrary to what *Galilæo* demonſtrates would happen if the Air did not hinder; who proves that Pendulums of different lengths [would *in Vacuo*] have the times of their Vibrations in ſub-duplicate Proportion to their lengths.

I took this Pendulum, and ſtanding over againſt a high Wall I clapt Two ſmall pieces of Boards together, and obſerved how long it was e're the Echo return'd, and I removed my Station till I found the Place whither the Echo return'd in about half a Second. But that I might diſtinguiſh the time more nicely, I clapt every Second of Time Ten or Fifteen times together; ſo that by this Means I could the better diſcover whether the Diſtances betwixt the Claps and the Echoes, and the following Claps were equal. And though it be very difficult to be exact, yet I could come within ſome few Yards of the Place I ſought for, thus: I obſerved the Two Places where I could but juſt diſcover that I was too near, and where I was too far off; and from the Mid-way betwixt them I meaſured to the Wall, which Meaſure doubled, was the Space that the Sound moved in half a Second.

Here follow the Numbers of *Engliſh* Feet which a Sound moved in one Second of time at ſeveral Trials.

		Feet.		*Feet.*
Merſennus	1.	1474	9.	1292
	2.	2050	10.	1378
Florentine *Exper.*	3.	1148	11.	1292
Mr. Boyle's *above*	4.	1200	12.	1185
	5.	1256	13.	1278
	6.	1507	14.	1290
	7.	1526	15.	1200
	8.	1150		

I have here added Four other Numbers; Two of them *Merſennus* mentions, but the firſt is that which he relies upon, being the Reſult of many Experiments that he tried; he ſpeaks of it in his *Balliſt. prop.* 39. and elſewhere. The Second is grounded upon an Experiment which he did not try himſelf, and he queſtions whether the Obſervation were accurate: He ſays, the Sound of a great Canon, which was heard in the Night 11″ after firing, paſſed every Second 1920 *French* Foot [*Tom.* 3. *pa.* 163.] The Third you have in the Book of the *Florentine* Experiments: The Academy *del Cimento* cauſed Six Harquebuſſes and Six Chambers to be fired one after another at the Diſtance of 5739 *Engliſh* Feet, and from the Flaſh to the Arrival of the Report of each was 5″: And repeating the Experiment at the mid-way, the Motion was exactly in half the time.

The Fourth Mr. *Boyle* mentions in his Eſſay of Languid Motion, *pa.* 24. where he ſays, he has more than once diligently obſerved, that the Motion of Sound paſſes above 400 Yards in 1″.

The reſt of the Numbers are collected from Experiments which I tried in ſeveral Places. When the Fifth was tried there was ſome Wind ſtirring, though not much. The Sixth, Seventh and Tenth were tried in a clear calm Morning: The Sixth and Seventh were tried in Two places in St. *John's Grove.*

The Twelfth Experiment was tried Two ſeveral Mornings, the Place where I ſtood was about 395 Yards from the Wall, and the Echo returned in 2″. The Thirteenth was tried at the Diſtance of 213 Yards from the ſame Wall. And the Fourteenth another Morning at 215 Yards Diſtance from it; in each of them the Sound was reflected in 1″.

The Eighth Experiment was tried in St. *John's Cloiſter*; and the Fifteenth in *New-College-Cloiſter*, where the Sound was toſſed from one end to another, forward and back again ſeveral times, like that which *Merſennus* obſerved at *Milan*, where he thinks his Voyce was reflected thus at leaſt Ten times, [*Reflex*, *ch.* 20. *p.* 164.] In *St. John's-Cloiſter*, which is 104 Foot and 7 Inches long, I ſtood at one end, and the Sound was repeated 11 times in 2″. On the North ſide of *New-College-Cloiſter*, which is 160 Foot and 8 Inches long, I ſtood at one end and a Clap was repeated 8 times in a little more than 2″; I gueſs there were 7¼ Echoes in 2″. From the Number of Echoes here in 2″, I computed the Swiftneſs of the Sound.

Merſennus and the Academy *del Cimento* conclude, That Sounds are all of the ſame Quickneſs, whether they be great or ſmall, and whatever Temper the Air is of, though *Merſennus* was once of another Mind: But *Kircher*, from ſeveral Experiments, infers, That loud

Sounds move quicker than little ones, [*Phon. pa.* 14.] Dr. *Plot* alſo tells us, the Echo returned the Sound of a Piſtol much quicker than a Voice; and that it repeated more Syllables in the Night than in the Day, [*Oxf. pa.* 7.] whence it follows that the Sound moved ſlower in the Night than in the Day. *Kircher* ſays, that an Echo which in the Night repeated Fourteen Syllables, repeated but Seven of them in the Day, [*Muſurg. li.* 9. *pa.*244.] which ſeems very odd. Becauſe there ſeems to be ſo great Affinity betwixt the Undulation of Water, and the Propagation of Sound, therefore the Academy *del Cimento* tried ſome Experiments about the firſt; and they tell us, that the larger the Stone is which is thrown into the Water, and the greater the Force, by ſo much is the Undulation ſwifter: Though *Gaſſendus* had before affirmed, that the Undulations of Water are all equally ſwift. And I have often obſerved, that when a Stone has been thrown into the Water, the further the Undulations removed from the Center, the greater was the Diſtance from one another, even of thoſe that rolled the ſame way: So that the Motion of each precedent Undulation was quicker than that which followed it. If this may be allowed for any Argument, it makes for *Kircher*'s Opinion.

By ſome of thoſe Experiments that I tried, I am inclined to think, that the Sound moved quicker when it was Calm, than in a Wind, even when the Sound moved half way with the Wind. Some other Experiments ſeem'd to me to confirm an Opinion of *Kircher*'s, who ſays, That a Sound moves ſwifter at firſt than afterward, as is uſual in other violent Motions.

There is ſeldom any Echo, where there is not ſome Wall, Wood, Bank, or ſuch like, directly oppoſite, that may reflect the Sound to the Perſon that makes it; but in *St. John's Grove*, if you ſtand near the Gate leading

from

from the College to the Grove, and clap, the Echo will return to you from the *Ball-Court*, though a Line drawn from you to the *Ball-Court* be not perpendicular to the Wall there, but as much oblique as the Line *AB* in *Fig.* 1 is to the Line *BC*; where *A* repreſents the Gate, *BC* the *Ball-Court-Wall*, and *BD* another Wall. Or if you ſtand at *E* the Corner of the Grove next to *Trinity*, and clap, the Echo will return to you from the *Ball-Court*.

In the ſame Grove I ſtood about Twenty Yards from the ſame Gate, and the Gate being ſhut, I clapt, and at other times ſtamped, and the Echo returned from the Gate as loud, if not louder, than the Clap or Stamp.

An Echo reflected from a Gate or Door has uſually a baſer and duller Sound than that which is returned from a Wall, this being much brisker.

As I have been walking towards a Wall, I have clapped my Hands together ſeveral times, and I could diſtinguiſh the Echo from the Clap, till I came within Seven or Eight Yards of the Wall.

In the Cloiſters, where, as was ſaid before, the Echo was repeated ſeveral times, the firſt Repetition ſeemed to be ſlower than the ſecond or the third; but of all the Repetitions, beſides the firſt, the ſubſequent ſeemed ſlower than the precedent.

I have obſerved the Toſſing of a Sound forward and back again, in very many Places where there are parallel Walls; and where the Diſtance of the Walls is leſs, there the Echoes follow one another quicker.

Whereſoever a Sound was thus toſſed betwixt Two Walls, if I ſtood about the middle, I could hear the Sound twice as quick, that is, twice as often repeated in 1″, as if I ſtood near one Wall; the Sound being reflected to me from both ends, when I ſtood in the middle.

In

In *Trinity Ball-Court*, which is repreſented by *Fig.* 2. when I ſtood and clapt at *B*, Three or Four Yards from the end of the Wall *C*, or at *A*, which is oppoſite to *B*, the Sound was toſſed betwixt the oppoſite Walls; but not half ſo long time as when I ſtood betwixt the Walls. In Places where there are parallel Walls, not above Six or Eight Yards aſunder, as in *Trinity Ball-Court*, and at the Entrance into *St. John's-Grove*, &c. I have heard the Echoes of a Clap following one another diſtinctly enough; but there the Echoes of a Muſical Note, which was longer than a Clap, were ſo confuſed, that they ſeemed one continued long Sound: which makes me think, that the Echo in ſome Vaults, is nothing elſe but the Sound toſſed betwixt the Side-Walls, and betwixt the Top and Bottom. This alſo makes me conjecture, that the Reaſon why Stringed Muſical Inſtruments give a greater and longer Sound to the Strings, than if the Strings were fixt to a ſingle Board, may be this; becauſe the Sound is toſſed from Side to Side in the Belly of the Inſtrument.